भारतीय मानक
Indian Standard

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ठंडे पानी के टावरों का परीक्षण — रीति संहिता

(पहला पुनरीक्षण)

Code of Practice for Testing of Water Cooling Towers

(First Revision)

ICS 66.045.5:620.16:006.76

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards after the draft finalized by the Refrigeration and Air-conditioning Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard was originally published in 1986. The experience gained in the industry necessitated the revision of this standard incorporating technological changes during past few decades.

The major additions in this revision are as follows:

a) Terminologies;
b) Conducting test; and
c) Consistency of test result.

The composition of the Committee responsible for the formulation of this standard is given in Annex A

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’.

Indian Standard

CODE OF PRACTICE FOR TESTING OF WATER COOLING TOWERS

(First Revision)

1 SCOPE

This Indian Standard describes recommended code of practice for performance testing of water cooling towers.

2 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

2.1 Cooling Tower

A Cooling tower is a type of heat exchanger, in which the process water comes in contact with the atmospheric air, and heat is rejected to the atmosphere by way of evaporation of some percentage of process water. The cold water, which is near the wet bulb temperature, is returned to the system.

The water surface is extended by filling, which presents a film surface or creates drops due to splashing or by spraying which produced droplets.

2.2 Air Flow

Total quantity of air flowing through the cooling tower.

2.3 Inlet Air Wet Bulb Temperature

Average wet bulb temperature of the air at inlet to the cooling tower.

2.4 Circulating Water Flow

The quantity of hot water flowing into the cooling tower.

2.5 Hot Water Temperature

Temperature of circulating water entering the cooling tower.

2.6 Re-cooled Water Temperature

Temperature of circulating water leaving the cooling tower.

2.7 Cooling Range

Difference between the hot-water temperature and the re-cooled water temperature.

2.8 Heat Load

Rate of heat removal from the circulating water within the cooling tower.

2.9 Approach

Difference between the re-cooled water temperature and the inlet air wet bulb temperature.

2.10 Evaporation Loss

Water evaporated from the circulating water and discharged into the atmosphere by the fan.

It is represented by the percentage of circulating water.

2.11 Drift Loss

Water lost from the cooling tower as liquid droplets entrained in the outlet air. It is represented by the percentage of circulating water.

2.12 Purge or Blow Down

Water discharged from the system to control the concentration of salts or other impurities in the circulating water. It is represented by the percentage of circulating water.

2.13 Make Up

Water added to the circulating water system to replace water loss from the system by evaporation, drift, purge and leakage. It depends upon cycle of concentration**.** It is represented by the percentage of circulating water.

2.14 Cold Water Basin

A device underlying the tower to receive the cold water from the tower and direct its flow to the suction line or sump.

2.15 Packing or Fill

The material which forms the heat transfer surface or creates droplets of water within the tower and over which the water is distributed in its passage down the tower.

2.16 Water Distribution

The arrangement whereby the water is conveyed to all parts of the packing at the top of the tower.

2.17 Casing or Cladding

The facing material which surrounds the packing and retains the water within the tower.

2.18 Tower Pumping Head

The head of water required at the inlet to the tower measured above the basin kerb to deliver the circulating water through the distribution system.

2.19 Fan Power

The power input to the fan assembly excluding power losses in the driver.

2.20 Fan Drive Assembly

Components for providing power to the fan, normally comprising driver, drive shaft and transmission unit and primary supporting members.

3 TECHNICAL GUARANTEE

3.1 The object of the test procedure is to determine the overall operating characteristics of the cooling tower and to verify the technical guarantee as agreed between the purchaser and the supplier.

3.2 The guarantee shall cover functional and thermal performance of the cooling tower in terms of quantity of water, cooling range, approach, and inlet air conditions within the conditions of validity specified in **4**.

4 CONDITIONS OF VALIDITY OF TESTS

In determining the performance and thermal efficiency of cooling towers, the following conditions of validity shall be fulfilled.

These conditions may also form the basis for contractual agreement between the purchaser and the supplier.

4.1 Conditions of Equipment

At the time of test all equipment and system shall be in proper operating condition and the following checks shall be made.

4.1.1 Water distribution system shall be clear and free from foreign materials which may clog or impede normal water flow.

4.1.2 Mechanical equipment shall be in good working order and set for design duty.

4.1.3 Drift eliminators shall be clear and free from algae and other deposits which may impede normal air flow.

4.1.4 Fill Packing shall be level and free from foreign material, such as oil, scale or algae.

4.1.5 Water level in water basin shall be at normal operating elevation, immediately prior to the test.

4.1.6 Wherever possible the make-up and purge should be shut off during the test in the interest of simplicity and accuracy.

4.1.7 Appropriate location and facilities must be provided to place the measuring equipment including the flow meter and thermometer.

4.2 Conditions of Atmosphere

The test should be carried out during stable weather conditions with the following restrictions.

NOTE — The test must be carried in the day time and when the visibility is good.

4.2.1 The average wind velocity shall not exceed 5.0 m/s when measured at a height of 1.5 to 2.0 m above local ground level. However for 1.0 min it may reach 7.0 m/min.

4.2.2 The inlet wet bulb temperature should be within ± 5°C of the design wet bulb temperature. Readings may fluctuate but the rate of change in average wet bulb temperature shall not exceed l°C/min.

4.3 Variation from Design Conditions

The following variations of average test readings from design conditions shall be permissible.

4.3.1 Circulating water flow not more than 10 percent above or 10 percent below the design value.

4.3.2 Cooling range not more than 20 percent below or 20 percent above design.

4.3.3 Heat load not more than 20 percent below or 20 percent above design. Total dissolved solids in the water shall be within ± 10 percent of agreed limits**.**

4.3.4 During the hour selected as being representative of the test conditions, the difference between maximum and minimum readings of circulating water flow, cooling range and heat load, shall not exceed 5 percent.

5 TEST REQUIREMENT

5.1 Functional Test Requirements

In order to establish that the cooling tower is fully operational and that the mechanical equipment is functional in accordance with the design requirements, checks should be made on the equipment described in **5.1.1, 5.1.2** and **5.1.3** as follows:

5.1.1 *Fans*

a) The fan blades are angled for design duty;
b) The fan is centralized in the fan housing to ensure uniform tip clearance within the specified tolerances;
c) The fan rotates in the correct plane, and
d) The direction of rotation of the fan is correct.

5.1.2 *Fan Drive Assembly*

a) The fan drive is aligned within the specified tolerances;
b) The lubrication is in accordance with the manufacturer’s recommendations;
c) The fan power observed under no heat load conditions is within the capacity of the driver; and
d) There is no excessive mechanical noise or vibrations.

5.1.3 *Water Distribution System*

a) All the valves are operating freely;

b) The system is regulated for even distribution for single as well as multi cell towers; and

c) The water levels are correct with sufficient free board.

5.2 Performance Test Requirements

5.2.1 *Thermal Performance Tests*

To conduct a full thermal performance test, it is necessary to take readings of the following quantities:

Sl. No.	*Parameter*	*Unit*
(1)	(2)	(3)
i)	Wind velocity	m/s
ii)	Wet bulb temperature	°C
iii)	Dry bulb temperature	°C
iv)	Hot water temperature	°C
v)	Re-cooled water temperature	°C
vi)	Circulating water flow	m^3/s
vii)	Make up water quantity and temperature	m^3/s and °C
viii)	Purge water quantity and temperature	m^3/s and °C
ix)	Power consumption	kW

5.2.2 *Power Consumption*

5.2.2.1 *Pumping head*

It is to be checked that total head at the tower inlet is correct for design conditions.

5.2.2.2 *Fan power*

It is to be checked that the fan power is in agreement with that quoted for design. It should be determined by means of voltage, current, and power factor. The measurement will be done at the motor terminals and proper derating factor to be taken into consideration for motor efficiency.

5.2.3 *Amenities*

In the event of the test involving contractual obligations, covered by guarantee, observations may be required of the following:

a) Tower noise, and

b) Drift nuisance.

6 INSTRUMENTS AND METHODS OF MEASUREMENT

6.1 Measurement of Wind Velocity

The instrument recommended for the measurement of wind velocity is a rotating vane type anemometer.

6.1.1 Calibration of the instrument before use is necessary. Measurement shall be made in an open and unobstructed location to the windward side of the equipment at a horizontal distance sufficient to eliminate the influence of the upstream effects of the equipment and a vertical distance 1.5 to 2.0 m above local ground level.

6.1.2 The frequency of readings taken should increase with wind speed and gust effect, in order to arrive at a representative average result.

6.2 Temperature Measurement

6.2.1 *Measurement of Air Temperature*

The inlet wet bulb temperature shall be determined as the arithmetical average of measurements taken within 1.5 m of air inlets and between 1.5 and 2.0 m above the basin kerb elevation on both sides of the cooling tower, so as to bracket substantially the air flow to the tower.

The number of stations at which measurements should be taken depends upon the size of the cooling tower and the existence of neighbouring influences.

6.2.2 *Measurement of Water Temperature*

The location of the temperature measuring instrument shall be such that the true average temperature of the hot circulating water entering the distribution system of the cooling tower and the re-cooled circulating water entering the basin is determined. Make up and purge water temperature readings shall be taken in the piping immediately adjacent to the cooling tower.

6.2.3 *Temperature Measuring Instruments*

Temperature measurements shall be made with one or more of the following instruments:

a) Mercury-in-glass thermometers;

b) Thermocouples; and

c) Electric resistance thermometers.

The instrument accuracy shall be within ± 0.1 pecent.

In all measurement of wet-bulb temperature, sufficient wetting shall be provided and sufficient time shall be allowed for the state of evaporative equilibrium to be attained.

6.3 Water Flow Measuring Instruments

6.3.1 Volume measurements shall be made with either of the following instruments having an accuracy of ± 1 percent of the quantity measured:

a) Liquid quantity meter, measuring either mass or volume; and

b) Liquid-flow rate meter.

6.3.2 Liquid quantity meter should employ a tank having sufficient capacity to accumulate the flow rate for at least 2 min.

6.4 Measurement of Tower Pumping Head

The following measurements shall be taken in order that the pumping head may be evaluated:

a) Static pressure above atmosphere measured at the centre line of the water inlet to the tower and immediately adjacent to the connecting flange; and

b) The height above basin kerb level of the point at which the above static pressure is measured.

6.5 Measurement of Power Input to the Fan

The power consumption shall be the average power consumption in watts measured during head load test.

The power consumption shall not exceed by more than 5 percent of the value stated on the name-plate.

Electrical measurements shall be made with either indicating type or integrating type of instruments.

6.6 Measurement of Drift Loss

The amount of drift loss may be estimated by taking the difference between the quantity of make-up water flow and the sum of the purge flow and evaporation loss.

6.7 Measurement of Tower Noise

The total noise inclusive of the tower under full water and fan load shall be measured and also the background noise measured immediately before the test and exclusive of fan and water noise.

6.7.1 Noise level shall be measured by an industrial grade sound level meter on 'A' scale.

6.7.2 The microphone of the sound level meter shall be located out of doors, at least l to 5 m above local ground level and in position previously agreed between the purchaser and the supplier.

6.8 Conducting the Test

The duration of the tests should not less than one hour and test conditions should be stable, and also the visibility should be good. The number of readings per hour should be as given below:

a) Water flow : 3

b) Hot water temperature : 12

c) Cold water temperature : 12

d) Wind velocity : 12

e) Wet bulb temperature : 12

(3 reading should be taken at an interval of 10 s and average of 3 reading should be taken as one reading)

6.9 Consistency of Test Results

For reasonable test results, the variation in test conditions should be within following limits:

a) Circulation water flow should not vary more than 2.0 percent;

b) Heat load should not vary more than 5.0 percent;

c) Range should be within 5.0 percent;

d) Wet bulb temperature (WBT) should be within 1.0 degree during one hour of testing; and

e) Dry bulb temperature (DBT) should be within 3.0 degree during one hour of testing.

7 EVALUATION OF RESULTS

7.1 The measure of the thermal performance of a cooling tower is its ability to fulfil guaranteed conditions in terms of quantity of water, range, approach and inlet air conditions.

7.2 The reading taken on the site, should be jointly signed by the owner and the contactor.

This can be achieved by a direct comparison between the test results and the manufacturer's performance curves, and the results must be proved within a month.

7.3 Since, there is always anxiety about the performance of the cooling tower, a thumb rule may be used to assess the performance on the site within 5.0 percent error.

$$\text{Performance} = \frac{\text{LOADED CMH} \times \text{RANGE}}{\text{RATED CMH} \times \text{RANGE}} \times 100$$

Where,

CMH = Cubic Meter per Hour

Range = Cooling range (*see* **2.7**)

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Refrigeration and Air Conditioning Sectional Committee, MED 03

Organisation	*Representative(s)*
Indian Institute of Technology, Roorkee	Prof (Dr) Ravi Kumar (***Chairman***)
Annapurna Electronics and Services Ltd, Hyderabad	Shri G. K. Prasad Shri J. S. Sastry (*Alternate*)
Bureau of Energy Efficiency, New Delhi	Shri Saurabh Diddi Shri Manjeet Singh (*Alternate*)
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Nirma University of Science & Technology, Ahmedabad	Dr Vikash J. Lakhera
Refrigeration & Airconditioning Mfr Association, New Delhi	Shri Gurmeet Singh Shri R. K. Mehta (*Alternate*)

Organisation	*Representative(s)*
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Voluntary Organizationn in Interest of Consumer Voice, New Delhi	Shri H. Wadhwa Shri B. K. Mukhopadhyay (*Alternate*)
In personal capacity *(H.No. 03, Savita Vihar, Delhi)*	Shri J. K. Agrawal
In personal capacity *(506/2, Kirti Apartments, Mayur Vihar, Phase-1 Extension, Delhi)*	Shri P. K. Mukherjee
BIS Directorate General	Shri Rajneesh Khosla, Scientist 'E' and Head (Med) [Representing Director General (*Ex-officio*)]

Member Secretary

Ms Khushbu Jyotsna Kindo
Scientist 'B' (MED), BIS

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